Claims

1. (currently amended) A power plant system that can use a fuel that is a gas at ambient temperature and pressure, comprising:

at least one power plant;

at least one fuel storage container that stores fuel at a first pressure; and

at least one expander ~~that can receive fuel from~~ fluidly coupled to the fuel storage container ~~at a~~ for receiving fuel stored in the container at substantially the first pressure ~~and provide~~ that provides the fuel to the power plant at a second pressure that is lower than the first pressure, the system recovering energy from expansion of the fuel as pressure changes from the first pressure to the second pressure.

2. (original) The system according to claim 1, wherein the power plant comprises a fuel cell.

3. (withdrawn) The system according to claim 1, wherein the power plant comprises a combustion engine.

4. (original) The system according to claim 1, wherein the fuel storage container is selected from a pressure vessel for holding compressed gas, a pressure vessel for a bed of a gas sorbent, and a dewar for containing a liquefied gas.

5. (original) The system according to claim 2, wherein the fuel storage container holds compressed hydrogen gas or cryogenic liquid hydrogen.

6. (original) The system according to claim 2, wherein the expander is coupled to at least one device selected from a compressor, a pump, an adsorber rotor, or a vehicle propulsion device.

7. (currently amended) The system according to claim 2, wherein the fuel storage container holds cryogenic liquid hydrogen, the power plant system further comprising at least one heat exchanger ~~containing~~ housing a working fluid, the heat exchanger being juxtaposed with the fuel storage container such that heat can be transferred from the working fluid to the fuel in the fuel storage container.

8. (original) The system according to claim 2, further comprising a first conduit fluidly communicating between the expander and the fuel cell for carrying the fuel, wherein at least a portion of the first conduit is disposed within at least one heat exchanger such that the fuel is a coolant.

9. (original) The system according to claim 1, wherein the fuel comprises hydrogen, methane, natural gas, or propane.

10. (withdrawn) A power plant system that can use a fuel that is a gas at ambient temperature pressure, comprising:

at least one power plant;

at least one fuel storage container;

a first conduit fluidly coupling the fuel storage container and the power plant for delivering fuel from the fuel storage container to the power plant; and

at least one regenerative thermodynamic cycle engine thermally coupled to the first conduit such that heat may be exchanged between the fuel and a working fluid for the regenerative thermodynamic cycle engine.

11. (withdrawn) The system according to claim 10, wherein the power plant comprises a fuel cell.

12. (withdrawn) The system according to claim 10, wherein the power plant comprises a combustion engine.

13. (withdrawn) The system according to claim 10, wherein the fuel storage container is selected from a pressure vessel for holding compressed gas, a pressure vessel for a bed of a gas sorbent, and a dewar for containing a liquefied gas.

14. (withdrawn) The system according to claim 11, wherein the fuel storage container holds compressed hydrogen gas or cryogenic liquid hydrogen.

15. (withdrawn) The system according to claim 11, wherein the regenerative thermodynamic cycle engine is coupled to at least one device selected from a compressor, a pump, an adsorber rotor, or a vehicle propulsion device.

16. (withdrawn) The system according to claim 15, wherein the regenerative thermodynamic cycle engine comprises a Stirling engine.

17. (withdrawn) The system according to claim 16, further comprising at least one expander fluidly coupled to the first conduit between the fuel storage container and the fuel cell such that the expander can receive fuel from the fuel storage container at a first pressure and provide the fuel to the fuel cell at a second pressure that is lower than the first pressure.

18. (withdrawn) The system according to claim 17, further comprising:

at least one first heat exchanger fluidly coupled to the first conduit between the expander and the fuel cell;

at least one pressure swing adsorption module defining an inlet that is in fluid communication with a second conduit for carrying an air feed stream;

wherein at least a first portion of the first conduit and at least a portion of the second conduit are disposed within the first heat exchanger such that heat can be transferred from the air feed stream to the fuel.

19. (withdrawn) The system according to claim 18, further comprising a third conduit for carrying the working fluid of the Stirling engine, at least a first portion of the third conduit being disposed within the first heat exchanger such that heat can be transferred from the air feed stream to the working fluid of the Stirling engine.

20. (withdrawn) The system according to claim 19, further comprising a second heat exchanger housing at least a second portion of the first conduit and at least a second portion of the third conduit such that heat can be transferred from the working fluid of the Stirling engine to the fuel.

21. (withdrawn) The system according to claim 16, further comprising:

a second conduit for carrying an exhaust gas stream from the fuel cell;

a third conduit for carrying the working fluid of the Stirling engine; and

a heat exchanger housing at least a portion of the second conduit and at least a portion of the third conduit such that heat may be transferred from the exhaust gas stream to the working fluid of the Stirling engine.

22. (withdrawn) The system according to claim 21, wherein the fuel comprises hydrogen, methane, natural gas, or propane.

23. (withdrawn) An electrical current generating system, comprising:

at least one fuel cell;

a fuel storage system; and

means for converting energy from release of fuel from the fuel storage system into mechanical power, heat transfer, or mechanical power and heat transfer.

24. (withdrawn) The system according to claim 23, wherein the means for converting energy comprises at least one device selected from an expander, a heat exchanger or a regenerative

thermodynamic cycle engine.

25. (withdrawn) The system according to claim 24, further comprising at least one gas delivery system that can deliver a gas to the fuel cell, the gas delivery system including at least one mechanically-powered apparatus mechanically coupled to at least one of the expander or regenerative thermodynamic cycle engine.

26. (withdrawn) The system according to claim 24, further comprising at least one gas delivery system that can deliver a gas to the fuel cell via a conduit that is thermally coupled to at least one heat exchanger such that heat can be exchanged between the gas and the fuel.

27. (currently amended) An electrical current generating system, comprising:

at least one fuel cell;

at least one hydrogen storage system;

at least one expander ~~that can~~ fluidly coupled to the hydrogen storage system to receive hydrogen from the hydrogen storage system at a first pressure and to provide the hydrogen to the fuel cell at a second pressure that is lower than the first pressure; and

at least one oxidant gas delivery system that ~~can produce~~ receives a feed gas comprising an oxidant at a first concentration and produces an oxidant-enriched gas comprising the oxidant at a second concentration greater than the first concentration for delivery to the fuel cell, ~~and that includes~~ the oxidant gas delivery system including at least one device that is coupled to the expander.

28. (original) The system according to claim 27, wherein the oxidant gas delivery system comprises an oxygen gas delivery system that includes a pressure swing adsorption module and the device coupled to the expander is selected from a compressor, vacuum pump, rotary adsorbent bed and rotary adsorber valve.

29. (original) The system according to claim 28, further comprising:

a first conduit for carrying an air feed stream to the pressure swing adsorption module;

a second conduit for carrying the hydrogen from the expander to the fuel cell; and

a heat exchanger housing at least a portion of the first conduit and at least a portion of the second conduit such that heat can be transferred from the air feed stream to the hydrogen.

30. (original) The system according to claim 27, wherein the hydrogen storage system comprises at least one container selected from a pressure vessel for holding compressed hydrogen gas, a pressure vessel for a bed of a hydrogen sorbent, and a dewar for containing liquid hydrogen.

31. (original) The system according to claim 28, wherein the pressure swing adsorption module comprises a rotary pressure swing adsorption module.

32. (original) The system according to claim 28, wherein the hydrogen storage system holds cryogenic liquid hydrogen, the electrical current generating system further comprising:

a first conduit for carrying an air feed stream to the pressure swing adsorption module; and

at least one heat exchanger juxtaposed with the hydrogen storage system such that heat can be transferred from the air feed stream to the cryogenic liquid hydrogen.

33. (original) The system according to claim 27, wherein the expander comprises a multi-stage expander.

34. (original) The system according to claim 27, wherein the expander comprises a positive displacement expander or an impulse turbine.

35. (withdrawn) An electrical current generating system, comprising:

at least one fuel cell;

at least one hydrogen storage system;

at least one oxidant gas delivery system that can produce oxidant-enriched gas for delivery to the fuel cell;

a first conduit for carrying an air feed stream to the oxidant gas delivery system; and

at least one Stirling engine thermally coupled to the first conduit such that heat may be exchanged between the air feed stream and a working fluid for the Stirling engine.

36. (withdrawn) The system according to claim 35, wherein the oxidant gas delivery system comprises an oxygen gas delivery system that includes a pressure swing adsorption system having at least one device coupled to the Stirling engine.

37. (withdrawn) The system according to claim 36, wherein the device coupled to the Stirling engine is selected from a compressor, vacuum pump, rotary adsorbent bed and rotary adsorber valve.

38. (withdrawn) The system according to claim 35, wherein the hydrogen storage system comprises at least one container selected from a pressure vessel for holding compressed hydrogen gas, a pressure vessel for a bed of a hydrogen sorbent, and a dewar for containing liquid hydrogen.

39. (withdrawn) The system according to claim 36, wherein the pressure swing adsorption module comprises a rotary pressure swing adsorption module.

40. (withdrawn) The system according to claim 35, further comprising at least one expander that can receive hydrogen from the hydrogen storage system at a first pressure and provide the hydrogen to the fuel cell at a second pressure that is lower than the first pressure.

41. (withdrawn) The system according to claim 40, wherein the expander comprises a multi-stage expander.

42. (withdrawn) The system according to claim 40, wherein the expander comprises a positive displacement expander or an impulse turbine.

43. (withdrawn) The system according to claim 35, further comprising:

a second conduit for carrying hydrogen from the hydrogen storage system to the fuel cell;

a third conduit for carrying the working fluid of the Stirling engine; and

a heat exchanger housing at least a portion of the second conduit and at least a portion of the third conduit such that heat may be transferred from the hydrogen to the working fluid of the Stirling engine.

44. (withdrawn) The system according to claim 40, further comprising:

a second conduit for carrying hydrogen from the hydrogen storage system to the expander;

a third conduit for carrying the working fluid of the Stirling engine;

a fourth conduit for carrying hydrogen from the expander to the fuel cell;

a first heat exchanger housing at least a portion of the second conduit and at least a first portion of the third conduit such that heat may be transferred from the hydrogen to the working fluid of the Stirling engine; and

a second heat exchanger housing at least a portion of the first conduit, at least a second portion of the third conduit and at least a portion of the fourth conduit such that heat may be transferred from the air feed stream to the hydrogen and the working fluid of the Stirling engine.

45. (withdrawn) The system according to claim 35, further comprising:

a second conduit for carrying hydrogen from the hydrogen storage system to the expander; and

an orthohydrogen-parahydrogen catalyst bed fluidly coupled to the second conduit.

46. (original) The system according to claim 27, further comprising:

a first conduit for carrying an air feed stream to the oxidant gas delivery system;

a second conduit for carrying the air feed stream to the oxidant gas delivery system;

a third conduit for carrying hydrogen from the hydrogen storage system to the fuel cell;

a fourth conduit for carrying hydrogen from the hydrogen storage system to the fuel cell;

a first heat exchanger housing at least a portion of the first conduit and at least a portion of the third conduit for transferring heat from the air feed stream to the hydrogen;

a second heat exchanger housing at least a portion of the second conduit and at least a portion of the fourth conduit for transferring heat from the air feed stream to the hydrogen;

a first feed air shutoff valve fluidly coupled to the first conduit between the first heat exchanger and the oxidant gas delivery system;

a second feed air shutoff valve fluidly coupled to the second conduit between the second heat exchanger and the oxidant gas delivery system;

a first feed air exhaust valve fluidly coupled to the first conduit between the first heat exchanger and the oxidant gas delivery system;

a second feed air exhaust valve fluidly coupled to the second conduit between the second heat exchanger and the oxidant gas delivery system;

a first hydrogen shutoff valve fluidly coupled to the third conduit between the hydrogen storage system and the first heat exchanger; and

a second hydrogen shutoff valve fluidly coupled to the fourth conduit between the hydrogen storage system and the second heat exchanger.

47-69 (cancelled).

70. (original) The system according to claim 4, wherein the fuel storage container comprises a pressure vessel that includes a bed of a physical adsorbent.

71. (original) The system according to claim 70, wherein the adsorbent is selected from a carbon material and a zeolite.

72. (original) The system according to claim 4, wherein the fuel comprises hydrogen and the fuel storage container comprises a pressure vessel that includes a bed of hydride forming metal or metallic alloy.

73. (withdrawn) The system according to claim 10, wherein the working fluid for the regenerative thermodynamic cycle engine is substantially identical to the fuel gas.

74. (withdrawn) The system according to claim 10, wherein the working fluid for the regenerative thermodynamic cycle engine and the fuel gas comprise hydrogen.

75. (withdrawn) The system according to claim 13, wherein the fuel storage container comprises a pressure vessel that includes a bed of a physical adsorbent.

76. (withdrawn) The system according to claim 75, wherein the adsorbent is selected from a carbon material and a zeolite.

77. (withdrawn) The system according to claim 13, wherein the fuel comprises hydrogen and the fuel storage container comprises a pressure vessel that includes a bed of hydride forming metal or metallic alloy.

78. (original) The system according to claim 2, further comprising:

a first conduit for carrying an exhaust gas stream from the fuel cell; and

at least one heat exchanger juxtaposed with the fuel storage container such that heat can be transferred from the exhaust gas stream to fuel in the fuel storage container.

79. (withdrawn) The process according to claim 61, further comprising intermittently transferring heat from the hydrogen stream to the regenerative thermodynamic cycle engine working fluid.

80. (original) The system according to claim 29, further comprising a third conduit bypassing the heat exchanger for carrying the air feed stream to the pressure swing adsorption module.

81. (previously presented) The system according to claim 1 configured to generate mechanical power and/or a refrigeration effect by releasing the fuel from the fuel storage container.

82. (previously presented) The system according to claim 1, further comprising at least one fuel transport device at least partially powered by energy generated by releasing the fuel from the fuel storage container.

83. (previously presented) The system according to claim 1, further comprising at least one fuel enhancement device configured to make use of a refrigeration effect generated by releasing the fuel from the fuel storage container.

84. (previously presented) The system according to claim 1, wherein the expander is configured to allow the fuel to expand substantially isentropically.

85. (previously presented) The system according to claim 1, further comprising a mechanical coupling in communication with the expander.

86. (previously presented) The system according to claim 1, further comprising an electrical coupling in communication with the expander.

87. (previously presented) The system according to claim 1, wherein the expander comprises a multi-stage expander.

88. (previously presented) The system according to claim 1, wherein the expander comprises a positive displacement expander.

89. (previously presented) The system according to claim 1, wherein the expander comprises an impulse turbine.

90. (previously presented) The system according to claim 2, wherein the expander is coupled to a coolant pump for the fuel cell.

91. (previously presented) The system according to claim 27, further comprising a shaft mechanically coupling the device and the expander.

92. (previously presented) The system according to claim 27, wherein the device coupled to the expander is a compressor for compressing an air feed to the oxidant gas delivery system.

93. (previously presented) The system according to claim 27, wherein the device coupled to the expander is a blower for delivering an air feed to the oxidant gas delivery system.